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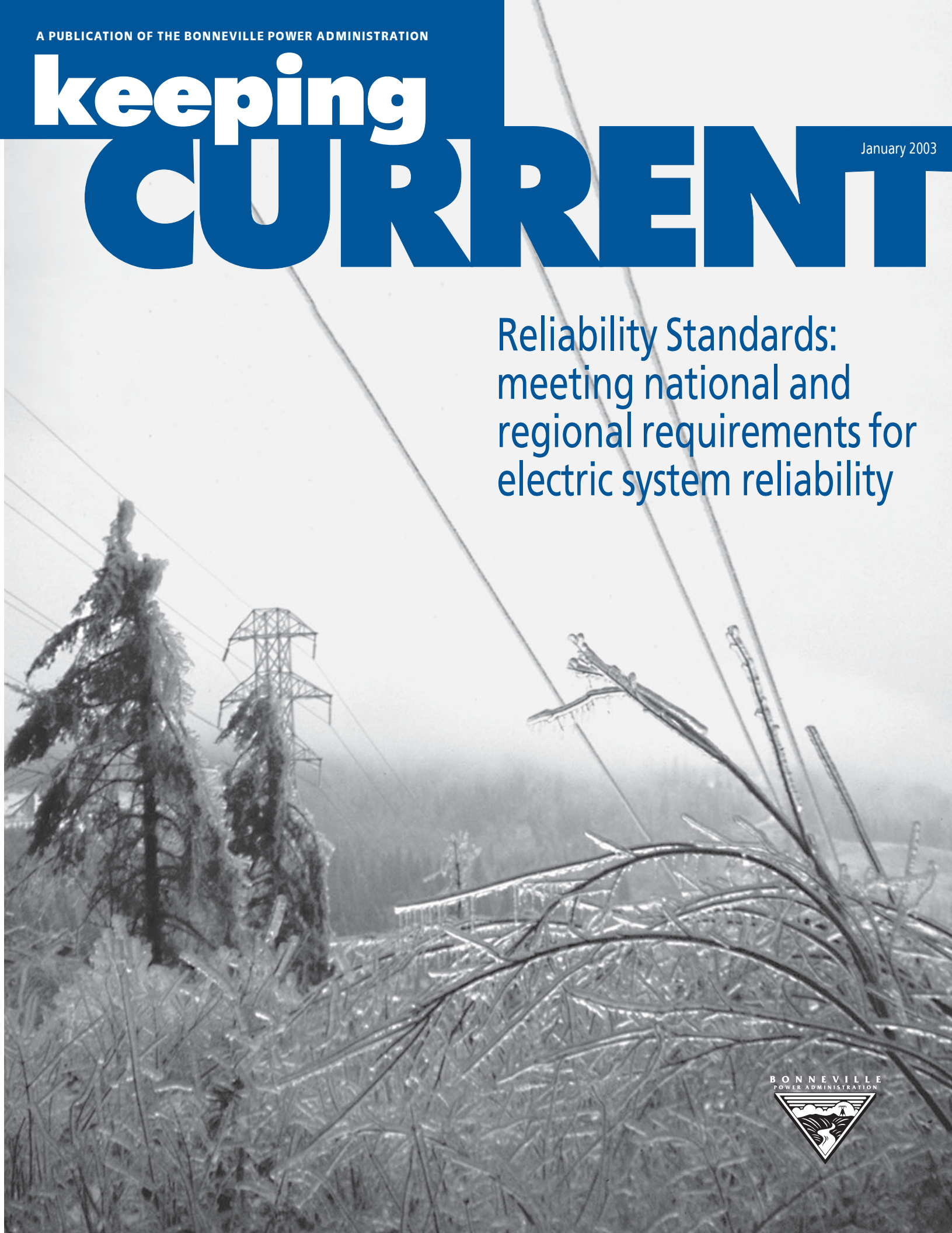
Reliability Standards: meeting national and regional requirements for electric system reliability



BONNEVILLE POWER ADMINISTRATION

On Nov. 9, 1965, five high-voltage transmission lines carrying power from a hydroelectric plant on the Niagara River to Toronto tripped off line. A huge power surge traveled into the transmission system in New York, causing massive instability on the lines. Within moments, the lights went out over an 80,000 square-mile area. The blackout, which occurred at the peak of rush hour on a Tuesday afternoon, directly affected over 30 million people in the Northeastern United States and Canada.

The Northeast blackout of 1965 was a reliability failure on a grand scale.

Fast forward three decades to the West Coast. In the early afternoon of Aug. 10, 1996, a 500-kilovolt line carrying power from the Seattle area to Portland tripped off. This caused an overload on other lines in the same north-south transmission corridor. Over the course of the next five minutes, as operators struggled to resolve the problem, the overloaded lines tripped, causing power flowing from Canada to California to surge through lines east of the Cascades. The resulting electrical disturbance triggered major problems that quickly spread throughout the system. In minutes, the power began to go off to 7.5 million people up and down the West Coast.

Major outages, such as these, are not just inconvenient. They are dangerous and costly, straining emergency services and bringing commerce to a standstill. With little or no warning, outages can seriously affect millions of people.

The West Coast blackout in 1996 is estimated to have cost the economy at least $2 billion. Serious damage was done to generating equipment when the transmission grid failed, and it took several days to get some large thermal and nuclear plants back into service.

With so much at stake, reliability of the bulk electric system (see definition below) is paramount. And it is one of the main reasons the Bonneville Power Administration is pursuing its current package of transmission infrastructure projects.

Blackouts lead to uniform reliability standards

The Northeast blackout in 1965 led to formation of the North American Electricity Reliability Council (NERC). Before the blackout, electric utilities had their own internal reliability standards. There were also regional efforts to coordinate and promote consistent practices. But as events illustrated so dramatically on that November afternoon, when utilities are electrically connected to one another, the consequences of a failure can be widespread and disastrous.

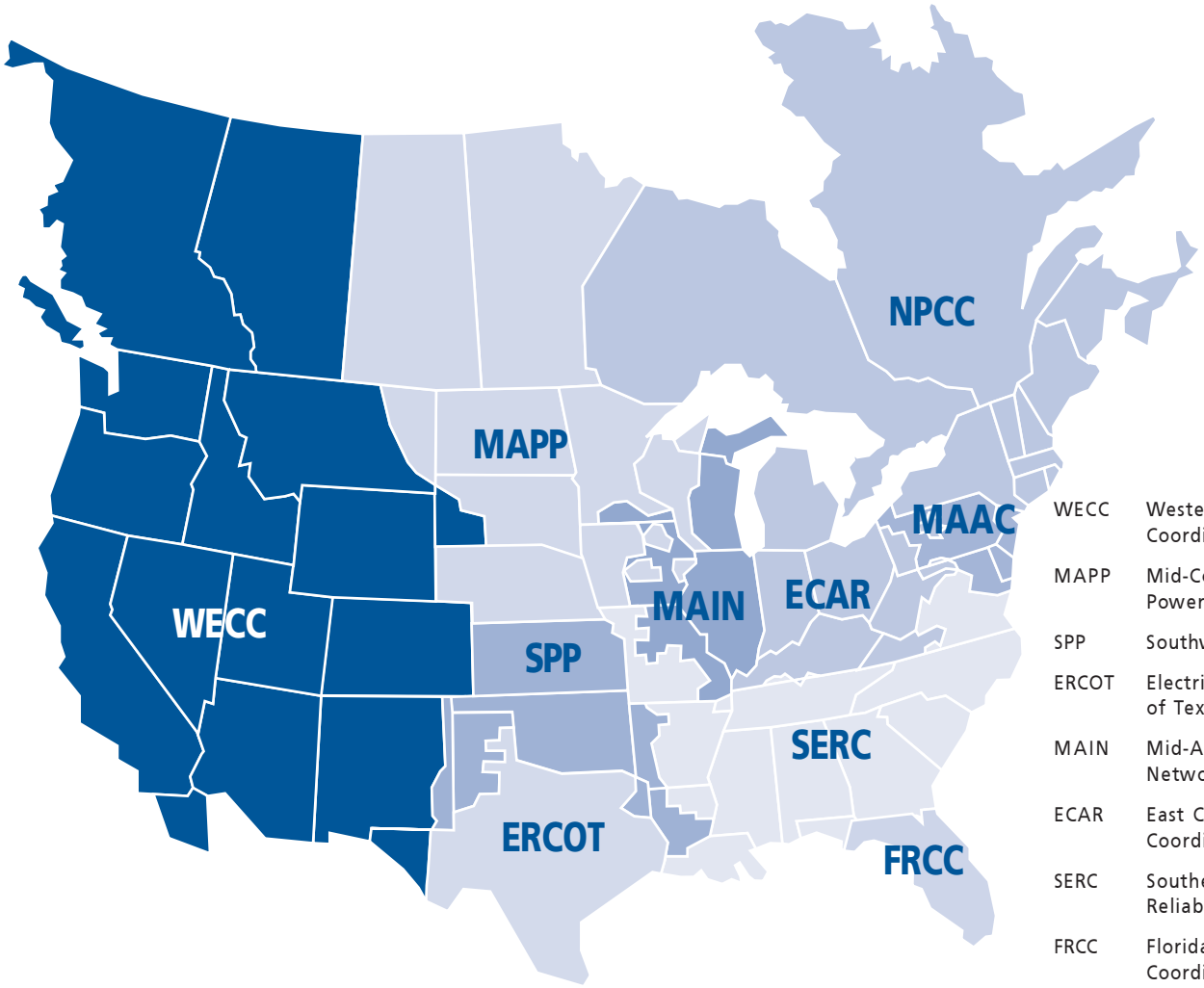
The electric power industry determined after the blackout that utilities needed to have uniform reliability standards. NERC, a not-for-profit corporation, was established in 1968 to develop standards and policies to ensure that the bulk electric system in North America is planned and operated reliably. NERC requirements were developed over a number of years, with members of the industry volunteering their expertise and NERC coordinating the efforts.

To manage the nationwide system, NERC set up 10 regional councils. These councils, which have the primary responsibility for reliability in their areas, draw their members from all segments of the electric power industry – investor-owned utilities; federal power agencies; rural electric cooperatives; state, municipal and provincial utilities; independent power producers;

NERC's definition of the bulk electric system

The portion of an electric utility system that encompasses the electrical generation resources, transmission lines, interconnections with neighboring systems and associated equipment, generally operated at voltages of 100 kilovolts or higher.

Regions of the North American Electricity Reliability Council



WECC	Western Electricity Coordinating Council
MAPP	Mid-Continent Area Power Pool
SPP	Southwest Power Pool, Inc.
ERCOT	Electric Reliability Council of Texas, Inc.
MAIN	Mid-America Interconnected Network, Inc.
ECAR	East Central Area Reliability Coordination Agreement
SERC	Southeastern Electric Reliability Council
FRCC	Florida Reliability Coordinating Council
MAAC	Mid-Atlantic Area Council
NPCC	Northeast Power Coordinating Council

The North American Electricity Reliability Council (NERC) consists of 10 regional councils that coordinate and promote consistent reliability standards.

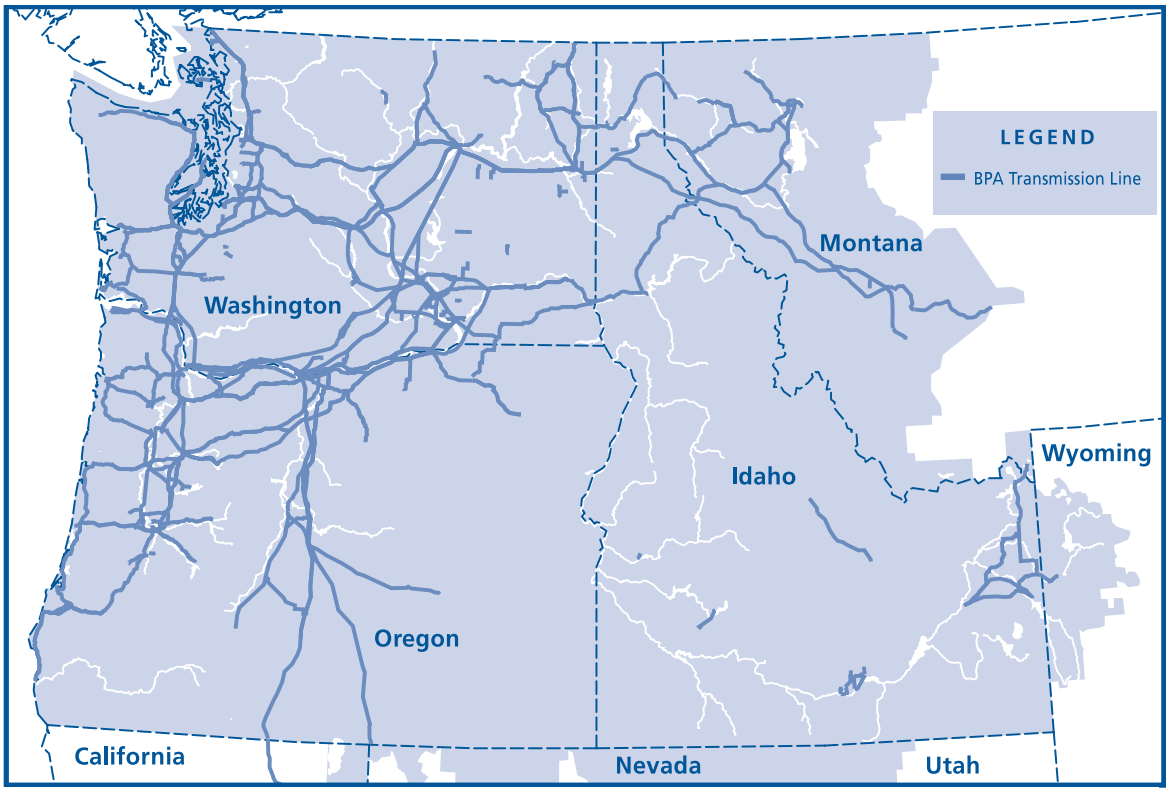
A merger to support competitive markets

The Western Systems Coordinating Council (WSCC) merged with Southwest Regional Transmission Association and Western Regional Transmission Association in April 2002 to form the Western Electricity Coordinating Council (WECC). Like its predecessor, WECC is responsible for coordinating and promoting electric system reliability. But WECC has additional functions in the western United States that support the industry's move to competitive power markets.

WECC will work to assure open and non-discriminatory access to transmission, provide a forum for resolving transmission disputes, as well as coordinate the operating and planning activities of its members. WECC is intended to complement efforts to form regional transmission organizations in the West.

WECC is the largest geographically of the nation's regional reliability councils, encompassing an area equivalent to over half the United States. Its members provide power to 71 million people in 14 states, two Canadian provinces and portions of Baja California in Mexico.

Bonneville Power Administration Transmission System



power marketers; end-use customers; and state regulators. Today NERC members supply virtually all of the electricity in the United States and Canada, plus a portion of Baja California in Mexico.

BPA and utilities in the West belong to the Western Electricity Coordinating Council (WECC), formerly known as the Western Systems Coordinating Council (WSCC). WSCC was formed in 1967, with 40 charter members representing 14 states and British Columbia, Canada. BPA was a member of WSCC from the outset. Today, WSCC's successor organization has 145 members and its geographic scope is about 1.8 million square miles.

NERC and WECC have established both system *planning* standards and system *operating* standards and policies. NERC requires that members of the regional councils meet the national standards, and where the national standards differ from regional standards, members must meet whichever is the most stringent. WECC standards take into account circumstances unique to the West, and include the NERC standards. BPA adheres to both WECC and NERC standards in planning and operating its transmission system.

Adequate and secure

BPA is the largest transmission owner in the Pacific Northwest, operating over 15,000 miles of high-voltage power lines. Despite considerable growth in the region, BPA's investments in transmission have been declining since 1975, and there have been no major additions to its transmission system since 1987. New investments are badly needed to ensure reliability.

BPA's Transmission Business Line (TBL) has undertaken a number of infrastructure projects in recent years, and maintaining reliability is one of three primary reasons for pursuing them. The other two are: to restore or increase the capability across key transmission paths and to integrate new generating plants into the electric power system. Whether it is the primary reason or not, reliability is an important element in all of TBL's construction projects.

NERC defines reliability in terms of two major

elements: adequacy and security. According to the official definition:

- Adequacy is the ability of the electric systems to supply the aggregate electrical demand and energy requirements of their customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.
- Security is the ability of the electric systems to withstand sudden disturbances, such as electric short circuits or unanticipated loss of system elements.

The system, in other words, must be capable of supplying the power needed by customers, and it must be able to do so even when unexpected things happen.

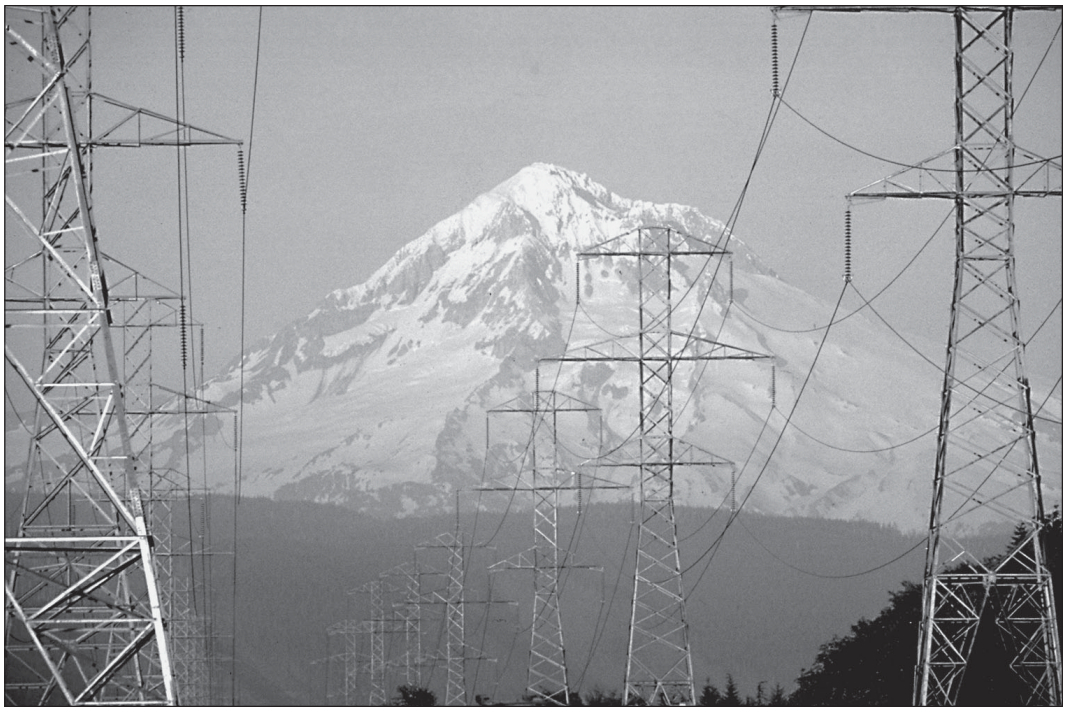
In the Pacific Northwest, large amounts of power move from hydroelectric projects on the Columbia River to urban centers hundreds of miles away. Power is also transmitted across the system from coal plants in Montana and Wyoming, as well as from hydro plants in Canada. The BPA transmission system must have the capacity to carry that power around the clock, according to the WECC standards, and it must be capable of doing so under a variety of expected conditions, such as line maintenance and variations in customer demand. The system must also be capable of withstanding unusual circumstances, such as a line loss or a severe weather event, like a winter "Arctic Express" that can bring days of subfreezing temperatures to the region. The Northwest experienced an Arctic Express in February 1989 and again in December 1990.

WECC planning standards spell out the fundamental requirements for assuring both adequacy and security of the transmission system in the West. The standards prescribe how reliable the system must be, and they categorize the types of routine and extreme events transmission operators must plan for and during which they must be able to assure they can continue to deliver electricity. Specifically, the standards dictate the thermal, voltage and stability criteria to which systems must be planned, designed, built and operated.

Reliability begins with planning

BPA plans for its transmission facilities with reliability as a top priority and WECC standards as the foundation. Planning starts with identifying needs or problems on the system. When a need is identified, as several have been in recent years, BPA's transmission planners conduct extensive computer modeling studies to develop alternative solutions. These studies incorporate the WECC standards.

BPA planners test the transmission alternatives, again with computer simulations, to determine whether they will provide acceptable performance and meet WECC standards once the project or improvement is in operation. WECC has established methods for planners



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to use in making these determinations. In addition to the planning and operating analyses, BPA performs economic and environmental assessments of its transmission alternatives.

The WECC standards categorize system disturbances according to their likelihood and severity. The standards list the type of events that might occur and then indicate what it is permissible for a system to do under the circumstances. For instance, the reliability standards require that the system remain operating without interruption to consumers if a single element, such as a transmission line or transformer, goes out of service unexpectedly. That means the system must be planned carefully, providing adequate capacity to reroute power that is traveling on a line should it fail. If the system loses two elements, a less likely event than losing one, the standards allow operators to take load and/or generation off long enough to stabilize the system if need be. Whenever a change is proposed to the system, such as adding a new generating plant, new reliability studies are done to determine how best to comply with the WECC standards when or if the change is made.

In the West Coast blackout of 1996, the power that was being transmitted on the 500-kilovolt line at the time it failed took an alternative transmission path. The loss of a single transmission line, such as this, is a contingency that is routinely considered in reliability planning. But on the afternoon of Aug. 10, the mix of events and operating conditions, including the subsequent unexpected tripping of generators, combined to cause instability in the system and ultimately led to a cascading outage. Cascading is a situation in which, like falling dominoes, one problem leads to another until the system can no longer continue to provide power.

As demand grows and more electricity is traveling through the transmission system during more hours of the day, the flexibility available to cover an unforeseen event begins to shrink. Some portions of the BPA system are already being loaded to the reliability limits for which they were planned throughout a season. BPA is addressing these situations in various ways, including transmission infrastructure projects that provide for new capacity.

BPA must not only plan and build its system according to the WECC reliability standards, it must also demonstrate that it can operate in compliance with WECC's operating standards and policies. WECC requires members to perform a high-level screening of utility transmission systems annually, assessing their performance and reporting any deficiencies. Utilities must respond to any violations found during the annual review.

An ounce of prevention

WECC planning standards aim to prevent problems before they occur. "Cascading," defined as "the uncontrolled successive loss of system elements," is a situation in which prevention is, by any measure, the best approach. Cascading can result from what the standards define as an "extreme event," such as the loss of all transmission lines on a right-of-way or the loss of all generating units at a power plant. WECC standards require planners to evaluate their systems for the risks and consequences of various equipment losses that could potentially lead to cascading and to respond to any problem areas where appropriate.

The standards are very stringent in specific cases, including installing two high-voltage transmission circuits on a single tower, because of the potential risk of losing both circuits due to a single event. Reliability standards on "double-circuiting" requires that the system be able to withstand an event that results in loss of both circuits, such as a tower failure or lightning strikes that affect both circuits.

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Keeping up with the times

NERC, the roles of its regional councils and the bulk electric system reliability standards have evolved over time. Every major outage is thoroughly dissected and the lessons learned often become part of the evolving standards.

Recently, WECC has been cautiously moving away from rigid "deterministic" or rule-based standards toward more flexible "probabilistic" standards that are based on the likelihood and consequence of a disturbance occurring. BPA's transmission planners look for opportunities to lessen the environmental impacts of construction projects and to make investments where they will be the most cost-effective. WECC's move to probabilistic standards has helped BPA lessen the environmental impact and/or cost of a project, while maintaining a high level of reliability.

NERC, WECC and other regional reliability councils have functioned for over 35 years as voluntary organizations, counting on reciprocity, peer pressure and mutual self-interest to keep the transmission system reliable and secure. But electric industry restructuring is having a serious effect on reliability.

In 1992, Congress passed the National Energy Policy Act and deregulated the country's wholesale power industry. The act spurred the growth of competition and structural change in the industry, all of which has altered the landscape for system reliability.

Deregulation is bringing new players into the business and transforming the roles of traditional players. The incentives and the responsibilities for investing in reliability are not the same in a restructured and competitive market, and a voluntary system of compliance is no longer adequate. In 1997, the NERC standards became mandatory for the regional councils and their members, as well as other participants in the electric industry.

NERC is in the process of transforming itself and its regional councils into organizations with enforcement capabilities. It has established a program to monitor and enforce compliance with its standards and is advocating for federal legislation to ensure it has the legal authority to do so. This is an effort BPA supports. In addition, NERC is revamping the way it develops standards to promote broader participation and consensus among industry participants.

In the West, WECC members have entered into a contract that covers a limited number of reliability standards. Signatories to the WECC contract, known as the Reliability Management System, have agreed to make some standards mandatory and to impose sanctions, including fines, for non-compliance.

The new competitive electricity environment is putting increasing demand on transmission services across the country. The Pacific Northwest, including BPA's transmission system, is no exception. With the

focus on transmission and its ability to support competitive electric power transactions, all users of the interconnected transmission system must understand its electrical capability and limitations. The future challenge is to plan and operate bulk electric systems in a way that provides open access to transmission and competitive marketing of power, and at the same time maintains reliability.

For more information

If you'd like more information about BPA's transmission projects, visit the Transmission Business Line Web site at *http://www.transmission.bpa.gov* or call toll free 1-888-276-7790.

To order additional copies of this publication, call the Public Information Center at 503-230-7334 in Portland, or outside Portland at 1-800-622-4520.

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